Remarks

1. Typing errors were corrected and some corrections were made to improve readability and easier comprehension.

2. No new matter is introduced by this amendment.

Respectfully submitted,

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impact-shock occurs to the desktop or to the notebook as the system is running-and this causes the head to ding as it is called in the field, to the hard disk surface, or sudden power failures result in head crash, or damage to heads or to surface. Nevertheless, it is desirable to have a fly height as close to the recording media as possible.

The low fly height and increased recording density can be understood from the following first equation that expresses the dependence of the length of a pulse width PW50 obtained from a recording transition on the recording system.

PW50={g2+4(d+a)(d+a+.delta.)}.sup.1/2 **(1)**

where

g = gap length of the recording head

d = the distance separating the head and media

a = 2 Mr.delta./Hc (length of a recording transition)

.delta.= film thickness

Mr.delta. = magnetization-thickness product

Hc = coercivity

This equation was provided by Williams and Comstock in "An Analytical Model of the Write Process in Digital Magnetic Recording, 17th Annual AIP Conference Proceedings, part 1, No.5, 1971, pp.738-742, American Institute of Physics.

Furthermore, disk tangential velocity is greater at outer tracks than at inner tracks that result in different wind speeds based upon where the slider is positioned. In rotary actuated drives, the slider changes skew angle from inner tracks to outer tracks. These differing wind speeds and differing skew angles cause variations in fly height.

Invention assumes zero disk slippage-therefore zero variation in track radius by

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and is also more reliable.

In accordance with the present invention, the above shortcomings of the former hard disk drive actuator arm system, is effectively overcome by a double integrated actuator arm-suspension assembly that moves upon a stationary micro-rail. Transducer head read/write head (denoted R/W hereinafter) height is based on a continuous contact pad assisted constant fly height that has a unique parking method.

It is an objective of the invention to provide a system can be applied to all form factors, where it would be proportionally smaller and fit into a small formatted box storage capacity, such as form factor 2.5 inch or 1.8 inch, 1 inch or even special application smaller drives, so that same system can be applied on a variety of systems as notebooks and laptops, and for special purpose applications-such as in special vehicles as in air crafts, space crafts and the like-of very small form factors-since small form factor is correlated to better shock resistivity .

It is an object of the invention to have a multiple number of R/W heads feature that would be possible and compatible with the high speed chips and processors.

It is an object of the invention to provide a system that has a logic that divides the total area of the disk to four quadrants with respect to an instant in time and the ability to have concurrent access to two quadrants at an instant. An instant in time is to be understood as a very short period in time between 1 ms to 5 ms. Thus it is based on an instant in time as correlated to the relative positions of the two pair of actuators and their concurrent access with respect to time.

The system consists of at least; a. one platter; b. Spindle, c. Dual actuator arm assembly that are made of two actuator arm members; d. at least one analog voice coil motor-

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DESCRIPTION OF THE PREFERRED EMBODIMENT

The system of this invention can be described by the following formula:

The 1 ms to 5 ms it takes for the concurrent full stroke access to a set of uninterrupted data tracks and sectors on two quadrants of disk area = (in every ¼ Π radians per one revolution of disk) X 2 (on two quadrants) X 4(by two pairs) X 2 (on both sides of the number of units of platters.) **(2)**

With reference to figure 1, the prior art has a rotating disk 10 and carriage arm 10c, where the transducer head 10b moves along a path 10a. At that instant the transducer head 10b can only access tracks that are on quarter 10d. Tracks on quadrant areas 10e, 10f and 10g are not accessible by the straight-arm actuator 10c at that instant in time. For example for any track on quarter area 10g to be accessible by transducer head 10b, the disk 10 must make many more revolutions than one single revolution or less than one revolution and even then the carriage arm 10c has to make many swinging motions on the path 10a until the desired track becomes accessible. The back and forth motions-direction reversals also involve vibrations as is indicated by 10h.

With reference to figure 2, the wing shaped dual actuation arm assembly 13 and 14 are able to reach concurrently two different quadrants 20 and 21 respectively of the disk 33. The reference center line C divides the half of disk 33 area further into two equal halves to indicate the limit that one of the pair member that reaches the inner reach border of actuator 13, that is, it shows the inner limit of the distance 17a that one of the pair member of wing shaped actuation-carriage arm 13 moves within the ½ quarter area, ½ of the radius of disk 33. Similarly the inner actuator member 14 moves within limited distance 18. Wing shaped dual actuation arm assembly structure 13 is moved by a linear analog voice coil motor 12 and

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wing shaped dual actuation assembly structure 14 is moved by a second linear analog voice coil motor 11 linearly, by moving the connection and mover member 13e (see fig. 7). When the wing shaped actuators arms 13 and 14 are positioned on different circumferential areas, a set of adjacent multiple number of tracks 22 and 23 become accessible for R/W functions. These multiple number of tracks 22 and 23 can reach R/W heads 26a with only less than one revolution of the disk 33. Furthermore, since the wing shaped geometry of actuators-carriage arms 13 and 14 each have a length that extends as an arc like shape along the concentric tracks of the disk 33 and conform to the track curvatures-arcs 22 and 23, not only a multitude of tracks 22 and 23 are reached concurrently, but also many complete sectors in a row 22c and 23c pass under the continuous-uninterrupted reach of the R/W heads 26a for a longer time. Therefore, many complete sectors can be identified instantly-instead of sequentially-as in the serial data transfer scheme. Sector interleaves and head skew would become more effective and efficient. A very fast input-output bus and large buffer in RAM would be needed for this system. Track 22a is the outer most border between inner most tracks and the outer tracks-that divides 1/2 of the radius of the disk to two halves, upon which actuators 13 and 14 move. Border tracks 22a of fig. 2 and the inner non-data zone 22d of fig. 14 are located adjacent to each other. Those skilled in the art will recognize that the complete hard disk sectors 22c and 23c depicted are not drawn to scale in FIG.2 , but are rather depicted as much thicker lines for visual clarity.

Referring to figure 2-upper right quadrant 21, the cutaway view of the multiple R/W heads 26a shows how the R/W heads 26a are in a series below the wings of the wing shaped dual actuator-carriage arm 14, and face the disk surface 33a. The disks 33 and 34 are turned by a spindle motor 32.

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With reference to figure 3, the two pairs of wing shaped actuator-carriage arms and suspensions 13 and 14 cover two quadrants 20 and 21 of the disk 33 area concurrently and can move independently. Data track 23a is one set of innermost tracks of the outer most set of tracks that are located on the outer 1/2 area of the disk 33. Similarly data track 22b is one set of the inner most tracks that are within the inner 1/2 area of disk 33. The limited designated distances 17 and 17a are assigned to each actuator members of the pair actuator 13. Similarly, the actuator pairs 14 move within the designated limited distances of 18 and 18a. The opposite quadrants 20 and 21 that the pair of actuators 13 and 14 function upon, are the areas over which the system has concurrent R/W capability. Pair actuator arms and suspension 13 moves on linear stationary micro-rail 16. Similarly, the pair of actuator arm and suspension 14 moves on linear stationary micro-rail 15. Also shown is one of the flexible printed circuit (FPC) electronic wiring 13c and 13d connection that connects wiring 13a to the drive electronics board.

With reference to figure 4, depicted in perspective view are both pairs of wing shaped actuators-carriage arms 13 and 14 that move upon the stationary micro-rails 16 and 15 respectively. This pair of actuator arms 13 enables access to two different quadrant areas 20 and 21 of the disks 33 and 34 concurrently. Due to the pair of actuators 13 and 14, a multitude number of inner tracks 22 and a multitude number of outer tracks 23 are read/written concurrently with only 1/2 of a revolution of the disk 33 and 34. The flexible printed circuit (FPC) electronic wiring board 13c and 13d that have a wiring pattern that have signal lines that connect the wing shaped actuator-carriage arms 13 and the actuator pair below for the second platter 34, 13a and R/W heads 26, 27, 28, 26a, 27a, 28a (all not shown) to the drive electronics board. The identical and parallel reference center lines C indicate

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the inner limit of the outer actuator 13-one member of the pairs of actuator 13 that is over the outer 1/2 tracks-of the disk 33, this is the inner limit reaching border for the outer one of the actuator 13. Same applies for actuator arm assembly pair 14.

With reference to figure 5, depicted is a partial ½ side elevational view of the disk of the two platters 33 and 34 and the R/W heads 26, 27, 28 and their single continuous contact pad system (not shown in this drawing) per each one R/W head 26-43, 27-43, 28-43, that move linearly on the stationary micro-rails 16 and 16a and 16b, by analog voice coil actuator motors 12, 12a and 12b, that also have a digital mode-which enables a fast skip function of data tracks 22, 22a, 23 (please see Fig. 2). The half of the disks of 33 and 34 are further divided into two identical and parallel to each other reference center-lines C to be indicative of the limits of the distance that one of the outer of the pair of the actuator-carriage arm system moves. These R/W heads 26, 27, 28 are able to read/write on disks 33 and 34 surfaces 33a, 33b and 34a and 34b concurrently. The spindle motor 32 of the double platter system is seen at left. The stationary micro-rails 16,16a and 16b cover one of the quadrant areas 20 of the two disks 33, 34 with both surfaces 33a, 33b and 34a and 34b being read and written upon. Note, not shown are the same components that are at the other half-quarter of the disk 33, (left side of figure 5,) for actuator-carriage arm 14 and R/W heads 26a, 27a, and 28a and their single continuous contacts pads 43. The micro-rail 15 covers the other half area of the disk 33.

With reference to figure 6, the wing shaped actuation-carriage arms 13 and 14 are able to reach concurrently two different quadrants 20 and 21 of the disk area, when these are in a symmetrical positioning-as depicted. When the wing shaped actuators 13 and 14 are positioned symmetrically on the same opposite concentric areas, a set of multiple tracks 24

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and 25 becomes accessible, this multiple number of tracks 24 and 25 reach R/W heads with only 1/2 of a revolution. The flexible printed circuit (FPC) board 13c and 13d and 14c and 14d electronics wiring-signal connection to said wing shaped actuators 13 and 14 that connect actuator and R/W heads 26, 27, 28 of actuator pair 13, and 26a, 27a, 28a of actuator pair 14 (not shown-see drawings 2,5,7) respectively to the drive electronics board. R/W heads 26 through 28a are not shown in this drawing, R/W heads 26a through 28a are the counterpart R/W heads of actuator-carriage arm 14 that is for quadrant 21.

With reference to figure 7, the wing shaped actuator-carriage arm 14 with the cutaway view of the R/W heads 26a that fly over disk surface 33a, where a set of multiple tracks 22 and a row of complete-uninterrupted hard disk sectors 22c come under the R/W heads 26a-as the heads 26a need not to be repositioned very frequently.

With reference to figure 8, the inner side wing shaped actuator-carriage arm and suspension 13 can move linearly on the stationary micro-rail 16 towards and away from the center of the disk surface 33a and thereby the R/W heads 26 of actuator 13, that fly over the disk surface 33a are capable to read/write on a set of multiple adjacent tracks 22, concurrently. The disks 33 and 34 are turned by spindle motor 32.

With reference to figures 9A and 9B, in sectional view, the transducer head 35 of the prior art has a wider head width gap 36 and greater head area 36a as compared to the invention transducer head width gap 37 and invention transducer area 37a. The fly height 39 of the invention R/W head 26 is higher by only few microns-and has continuous contact pads 43-where fly height of transducer 26 parts are only few microns higher than the lowest fly height applied in the state of the art drives in this industry. In order to reduce the area of the transducers, so that overall dynamic friction is reduced, the transducer head 26 of the

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arcs of the set of adjacent data tracks 23.

With reference to figure 17, this shows the partial plan view of actuator arm 13, with the cover plate of actuator completely removed-showing the multiple R/W heads 26 of the arc like formation, that conform to the data tracks 23. Thereby, this drawing shows the micro-actuation function of the integrated wing shaped actuator arm 13 member of the dual actuator arm assembly with respect to the adjacent tracks. When R/W heads 26 and thin pads 43 move from track origin O to track T7 the actuator 13 enables access to data tracks 23 by moving only a distance D.sub.o and R/W heads 26 are able to reach a set of points on track T7 as a function of the linear-adjacent track to track movement of the actuator and T7.sub.a, shows concurrent access of the arc section and continuous sector access component of the data tracks due to the curved shape of the actuator itself, where the limit on inner tracks is indicated by tangent reference line D.sub.r., that is the border of maximized reach due to the arc like geometric shape of actuator 13. The group of adjacent tracks are depicted as 23. Distance moved D.sub.o makes this distance to be multiplied and to be equal to D.prime.sub.o. As an example to adjacent tracks 23; actuator 13 makes distance D.sub.o to be equal to the micro distance DT7,with respect to the data tracks that are adjacent and can be accessed concurrently.

With reference to figure 18, it is a plan view of the prior art straight arm actuator 10c that must swing over a distance d.sub.p, as compared to the much shorter distance of the invention d.sub.o, that actuator 13 of the invention covers for an identical distance in terms of the number of adjacent tracks-from track origin O to track T7. The D.prime.o of figure 17 equals in distance to D.sub.p in figure 18.

With reference to figure 19, it is the side sectional elevation view of the continuous

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